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The CORNELL ENGINEER

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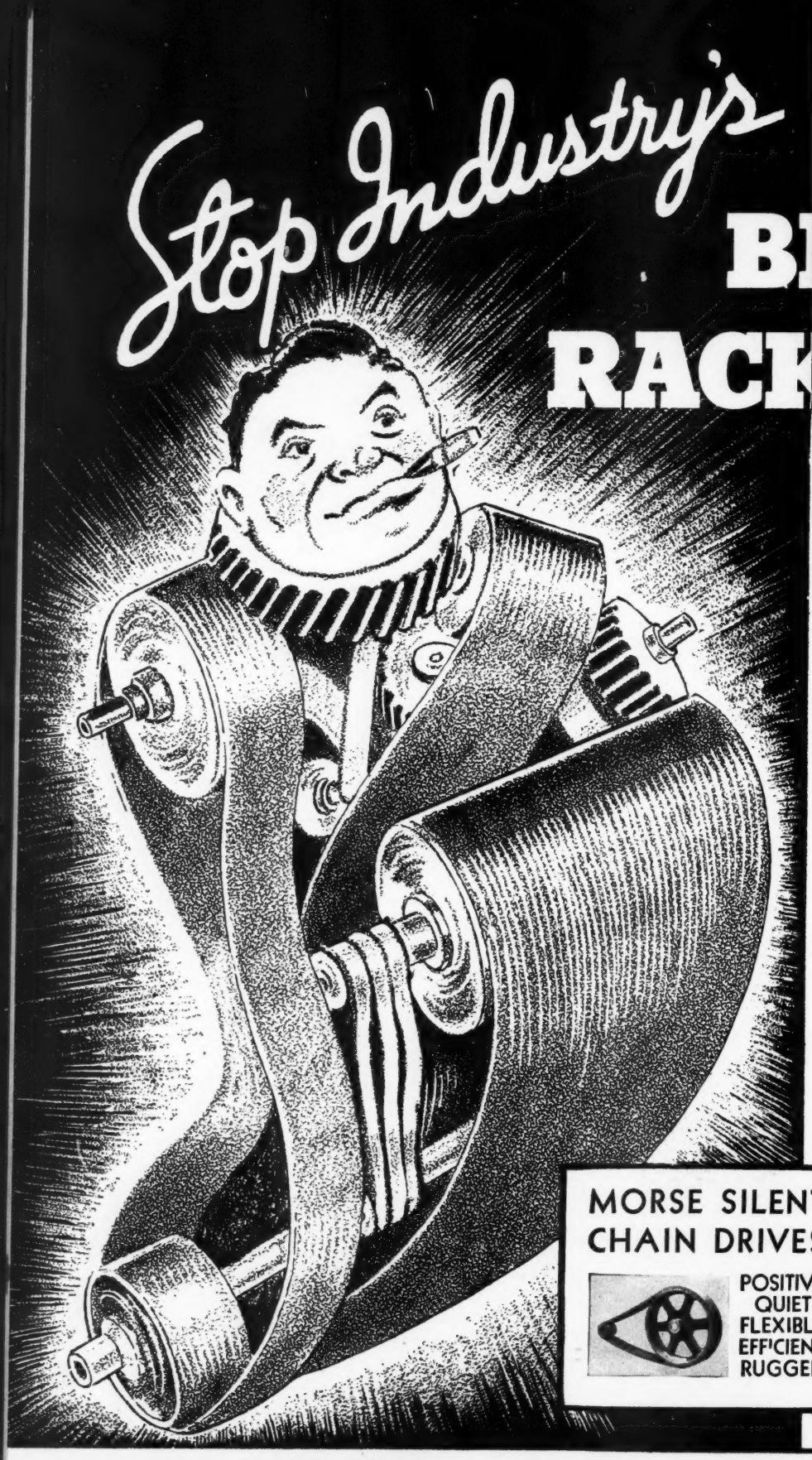
In This Issue: ENGINEERING EDUCATION *by* E. E. Seelye



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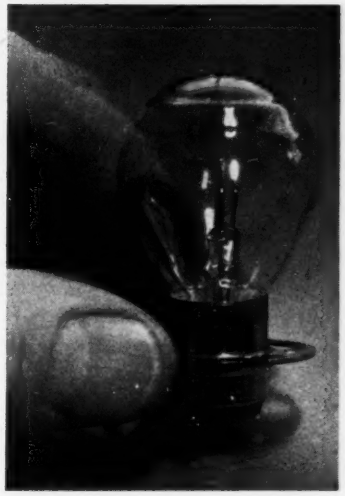

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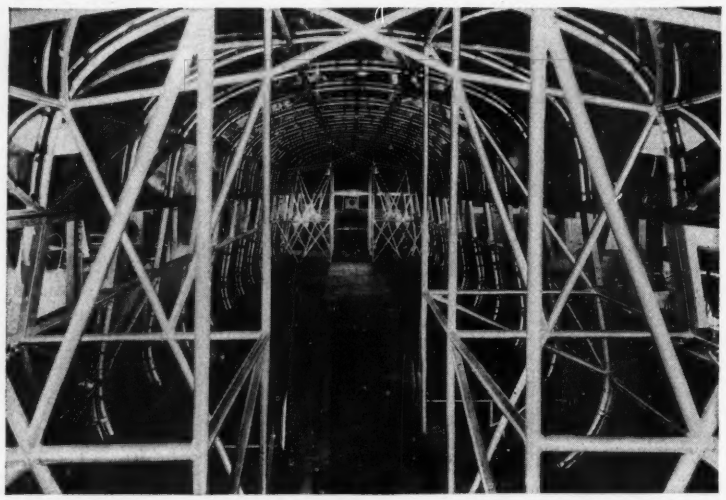

HERE'S HOW—the framework of the light weight, streamlined rail cars for high speed is Lindewelded from chrome-molybdenum steel tubing.

Mastery over all Metals

Welding Makes Jointless Structures Possible in Practically All Commercial Metals and Alloys

By A. B. KINZEL*

One great advantage of using welding is that practically every commercially available metal and alloy can be made by this means into a jointless assembly.

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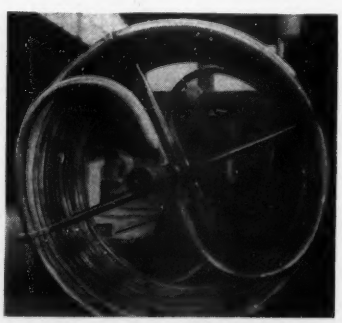

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*Chief Metallurgist, Union Carbide and Carbon Research Laboratories, Inc., Unit of Union Carbide and Carbon Corporation—This being a Business News Advertisement.

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Volume I FEBRUARY, 1936 Number 5

COMMENT

Professor Bangs takes a section from his new book on accounting and in this manner presents a simplified discussion of a modern necessity.

* * *

The technical article appears this month in a discussion by Mr. Carter, a Cornell graduate, on recent developments on measurement of flow of fluids. It is hoped that by articles of this type, the alumnus can have numerous developments summarized for him.

* * *

In his monthly letter to the members of the Cornell Engineering Society, President Stahl discusses the movement toward socializing the engineer.

* * *

Mr. Elwyn E. Seelye '04 presents a discussion rousing article on the policies of the faculty as observed by an active engineer.

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(Courtesy Detroit Edison "Synchroscope")

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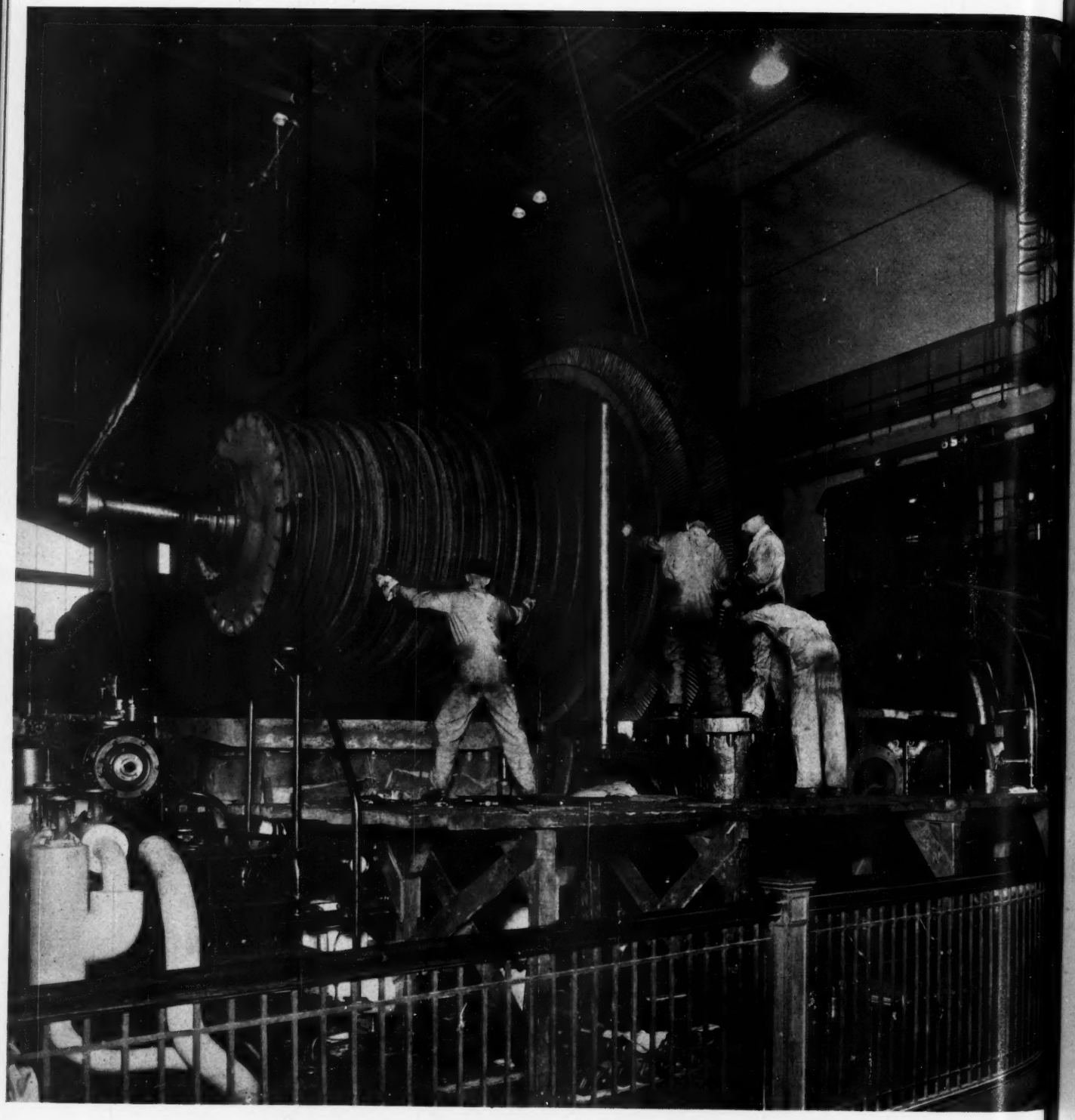

—*Courtesy Synchr*

REPLACING TURBINE ROTOR

THE CORNELL ENGINEER

Vol. I February, 1936 No. 5

Engineering Education

By Elwyn E. Seelye CE '04

In discussing Engineering Education it is first appropriate to set up objectives.

The stream of engineering graduates flows out into life and divides into three main divisions.

The first, and most important numerically, come those who use their technical background as a basis for business or executive careers. This group includes such men as salesmen, manufacturers and executives. Under this heading come types who have more or less lost their identity as engineers or technicians ranging from the realtor, the paint salesman, the patent lawyer, to the head of a great corporation such as our own Walter Teagle. These men are relying on their general abilities and personalities rather than on technical knowledge.

In contrast to this is the pure technician, such as the chemist, the machine designer, the designing engineer and the surveyor. Under this heading are found men ranging through surveyors, designing draftsmen, field engineers, and other cogs in engineering organizations, to distinguished technicians such as shine in the field of automotive engineering, aviation design and radio invention. Such men as Marconi and the late Steinmetz of the General Electric Company fall in this class which includes as a rule men who rely almost wholly on their technical ability and who would be successful no matter what degree of general ability or personality they might possess.

There is a third class of men with an engineering background who depend both on technical ability and general ability and personality. Under this class come consulting engineers, contractors, and into this class should fall the college professors. Typifying this group in our own Cornell circle fit such names as Fuertes, Ogden, and the Eidlitz brothers.

Now with these premises it is possible to set our objectives more clearly.

Firstly we are to develop three types of men—the man of general ability and personality, the technician, and the composite man.

Clearly if we turn out a fine technician with a subnormal personality we have not made a failure.

And, conversely, if we turn out a man of general parts deficient in depth of technical knowledge we have made no failure either.

All this leads up to the need of a flexible, sympathetic and inspiring environment.

Thus we envisage a college where an embryo I. P. Church may find encouragement and help as he develops his lucid style of writing and teaching and not be forced into memorizing chemical formulae or badgered by a Marxian political theory, supposing such latter subjects to be uncongenial to him.

Again let us envisage an embryo Ezra Cornell whom we imagine a boy of ideals and vision with a passion to build, create and organize with a streak of ruthlessness. Let him be free to ride herd through college life, eagerly absorbing political economy or business administration and not humiliated by an inaptitude for conic sections or indeterminate stresses.

Let us then take it for our thesis that a set-up which does not provide for flexibility, sympathy and inspiration is defective.

Note the necessity of providing an entirely different course in a subject for the two types. The I. P. Church wants his mechanics with a wide deep scope. The Ezra Cornell wants a few fundamental principles that will stay with him while he is in the field constructing a telegraph line.

This leads up to an important indictment of teaching methods which extends right through from grammar school to college. Many subjects are crammed into inadequate space leading to faulty assimilation.

Elementary mathematics are taught with too much emphasis on formulae and tables with too little training in making statements.

Foreign languages are taught with a large emphasis on grammar by, as a rule, American teachers with the net

result the subject is made as uninteresting as possible for the student. His ear has no training and his powers of translation are at a minimum.

This sort of teaching is musty with medievalism.

First year college chemistry and physics have a very wide scope and are extremely technical. The average student who is not going to specialize in chemistry has very little permanent knowledge planted in him by one of these courses. Certainly a very disproportionate amount of time, including outside study is required for the results obtained. These courses may be entirely suitable for the I. P. Church but entirely unsuitable for the Ezra Cornell.

The results of a year of the calculus, known as "freshmen math," for engineering may be best summed up by the remark that Professor Church made to a sophomore class in Mechanics to the effect that most of the students came to him after a year of mathematics without knowing what the integral "dx" was. It would seem that a thorough drill in stating simple differential equations for the solution of practical problems could be made throughout one term of two or three hours a week and possibly repeated with a senior course of the same nature. Applying calculus to subjects which had been studied in the meantime would give the average student a certain permanent facility with this branch of mathematics.

As it is taught, there seems to be no fault to find with mechanics, the great pivotal subject of engineering accomplishment. However, mechanics should not be exclusively taught in one year. Its importance is such that it should be included in every year of the course as this repetition will tend to aid permanent assimilation. There has been a criticism that too much surveying is taught in a college of civil engineering. The writer believes this criticism is unwarranted. A large amount of planning is based on a correct comprehension of physical features and every engineer should be familiar with the methods of obtaining this physical data. Also, this is one subject where theory and field practice can be united in college resulting in thorough assimilation.

To return to this question of assimilation, the student, after a few years of cramming a large amount of information into one or two terms, develops the capacity for emptying his brain completely after the examination. This process might be termed an American "improvement" on education and might be termed the system of the vomiting minds.

Of course this system of crowding a large scope of technical knowledge into a large space, while evidently entirely wrong for our embryo Ezra, is just what the young Church desires. This points to the policy of increased repetition of the original course with plenty of deep technology available for the smaller classes of selected men who desire a high degree of technical knowledge in that particular subject.

The discussion of flexibility has also brought out the importance of assimilation and this points in turn to the importance of mixing practical experience with theory. This naturally brings us around to the Antioch idea which seems to have one main defect. Inasmuch as it is desired to give a lot more within the same time limits, an abbreviation of the college work plus a shortening of vacation times becomes a necessity. Would it not be possible to plan to have the students spend one month out of each college year either working or in practical observation which should be sufficient to vitalize the theoretical work which he is doing in college?

It has been brought out that the most numerically important body of engineering students will not follow the purely technical side of the profession and they must depend upon their ability and personality and general culture to succeed. The extra curricular activities provide a remarkably good laboratory for the development of these qualities, but one cannot expect this development to go very far if we are going to dose the student with fifteen to eighteen hours of class work plus three hours of preparation or, say, fifty-four hours of work a week. In the outside world the educated classes are working about thirty-nine hours per week so it would seem that the classes should be so arranged that the average student should not net more than a total of one hour of preparation to one hour of classroom, or, if need be, the classroom might be cut down to keep the work of the average student down to about forty hours. From another angle one might suggest that credit might be given for extra curricular activities.

Vital statistics show that physical health is not consolidated under the age of twenty-five and piling in too much work results in ineffectiveness in after-life. The race is run not in college but in after-life.

For inspiration we must look to the faculty and physical equipment. The writer, with his affection for his Alma Mater, hesitates to be frank on the subject of physical equipment because the criticism would seem destructive where it is a question of obtaining money, which is most difficult in these times. Nevertheless, one could say a good deal about the effect on the morale of the student and on the quality of the student who selects Cornell, of the physical equipment, and one might say further, without fear of exaggeration, that the buildings and equipment of the engineering colleges, particularly C E has changed very little in thirty years except for obsolescence.

That some responsibility lies with the faculty on this subject might be made the subject of some comparisons. For instance, Fuertes, with his independent income, is reputed to have given a large part of his salary to purchasing instruments. The morale of the School of Architects seems to be relatively high in spite of more or less inadequate accommodations.

Could not the directors or deans do something about obtaining money and building morale if they possessed the acquaintanceship derived from a successful outside career and the faculty of advertising? Research is an

(*Continued on page one twenty-two*)

Modern Measurement of Fluid Flow

W. A. Carter ME '13

One method for measuring the rate of flow of fluids through pipe lines that has been used for many years is the one employing orifice plates, venturi tubes, or flow nozzles in conjunction with differential pressure measuring instruments. The requirements of this method have become more exacting, as it is no longer practical to determine by direct weighing or volumetric measurement the rate of flow of condensate from the condenser of a large steam turbine, of water handled by large pumps, or of the air delivered by large compressors. As many units of these types are too large to be given acceptance tests in the shop, they must be tested in actual service under conditions making it desirable to utilize orifice plates, venturi tubes, or flow nozzles to measure the input or output.

Much work has been done to improve the technique of making such measurements with the devices and considerable more needs to be done.

Each of these primary devices constitutes a restriction in the pipe line that causes an increase in velocity and a corresponding decrease in static pressure. The differential between the upstream static pressure and the reduced static pressure due to the increased velocity varies practically as the square of the rate of flow over a wide range of flow. The slight deviation from this relation is due to the varying of the discharge coefficient with the velocity, as will be discussed later.

There are several locations for the high-pressure and low-pressure taps in use, each requiring a different set of discharge coefficients for the primary device.

Realizing the desirability of making and using these devices without the necessity of calibrating each installation, certain organizations have undertaken to establish the coefficients of discharge for certain shapes of these restricting devices and arrangement of pressure taps, and to set up rules for their use. The American Society of Mechanical Engineers and the American Gas Association with the cooperation of the National Bureau of Standards have just completed the first part of this work for a large range of pipe and orifice sizes. Rules for their use in the gas industry have been set up by the A.G.A. The work necessary in order to standardize upon the shape, location of pressure taps, discharge coefficients, and rules for use of flow nozzles is in progress on a large range of pipe sizes and nozzle sizes at the National Bureau of Standards under the auspices of the A.S.M.E. Little other than the work of the manufacturers has been done to establish the discharge coefficients for venturi tubes, and only part of these data have been made available to A.S.M.E. The International Standards Association has set up, and is about to publish, Recommended Unified Rules for Measuring the Flow of Fluids by Means of Nozzles and Orifice Plates. The rules are based largely upon the researches of R. Witte, of Germany, and prescribe a flow nozzle of different shape than that used in this country, although the orifice plate is quite similar to that used in the A.S.M.E.-A.G.A. researches. As the pressure taps are located differently than in American practice, the I.S.A. discharge coefficients are different also. The A.S.M.E. Power Test Code Committee will issue shortly the best coefficients and technique for use of American-type orifice plates, venturi tubes, and flow nozzles available at the time.

Most of the cases encountered in this kind of measurement involve turbulent flow for which the flow formulas represent the differential pressure varying as the square of the velocity. The transition from viscous, or streamline, flow to turbulent flow is not sharp. The Reynold's number has been recognized as useful in expressing the conditions of the flow of a fluid in a pipe, and is calculated from the diameter of the pipe, the velocity, density, and viscosity of the fluid, all in a consistent system of units.

$$\text{Reynold's number} = \frac{(\text{pipe diam.})\ (\text{velocity})\ (\text{density})}{\text{absolute viscosity}}$$

$$= \frac{(\text{pipe diameter})\ (\text{velocity})}{\text{kinematic viscosity}}$$

The upper limit of viscous flow is represented by a Reynold's number of approximately 2000, and the lower limit of turbulent flow by approximately 5000, the borderline conditions of flow lying between these limits.

For turbulent flow and for flow rates such that the reduced pressure in the restricting device is not less than 53 per cent of the upstream pressure there are several flow rate formulas.

The theoretical formula is:

$$Q = A\sqrt{2gh} \qquad \text{.....(1)}$$

where

Q = volume rate of flow, cu ft per sec

A = cross-sectional area of pipe at upstream pressure connection, sq ft

g = acceleration due to gravity

h = differential pressure across device, ft of fluid flowing

The formula applying to the actual condition is:

$$Q = KA\sqrt{2gh} \qquad \text{.....(2)}$$

where Q, A, g, and h are the same as in equation (1), and

K = coefficient of discharge, including the velocity of approach

= ratio of the actual flow to the theoretical flow

Equation (2) is sometimes written as:

$$Q = \frac{1}{\sqrt{1-\beta^4}} CA \sqrt{2gh} \quad \text{.....(3)}$$

where $\frac{1}{\sqrt{1-\beta^4}}$ = velocity of approach factor

β = ratio of diameter of restricting device to pipe at uptsream pressure tap

C = coefficient of discharge, excluding the velocity of approach

If the fluid is compressible, an additional expansion factor (Y) has to be included to allow for the expansion of the fluid in passing from the upstream to the low-pressure tap. The factor Y varies with gases having different ratios of specific heats at constant pressure and constant volume, with β, and with the ratio of the differential pressure to the upstream pressure. Thus, equations (2) and (3) for use with compressible fluids become

$$Q = KYA \sqrt{2gh} \quad \text{.....(4)}$$

and

$$Q = \frac{1}{\sqrt{1-\beta^4}} CYA \sqrt{2gh} \quad \text{.....(5)}$$

Conversion factors must be applied to each of these flow-rate formulas to correct for the difference in the density of the fluid being measured from that of the fluid used in the manometer which measures the differential pressure (h).

The coefficient of discharge for each combination of pressure taps varies with the diameter ratio (β), the Reynold's number ($\mathcal{R}$), and, according to some authorities, slightly with the size of the pipe.

In order to attain the highest accuracy in measuring the rate of flow of fluids with such differential pressure producing devices in the pipe line, the fluid should approach without swirls, with a symmetrical velocity front and the pipe on the upstream side should be smooth, especially if the diameter ratio (β) is greater than 0.55.

These ideal conditions are seldom attained in actual service, as elbows, short-radius bends, and valves are often close enough on the upstream side to seriously disturb the flow. One set of rules prescribe at least 20 diameters of straight pipe upstream if no swirls exist, or 50 diameters of straight pipe if swirls are present. In many power plants, it is impossible to provide such lengths of straight pipe, and it becomes necessary to resort to the use of straightening vanes from one to two diameters long, and installed some ten or more diameters in a straight run of pipe immediately upstream. An additional benefit would be derived by installing a perforated plate in the pipe a short distance upstream from the straightening vanes in order to flatten the velocity front if it is not symmetrical about the axis of the pipe.

Another condition in actual service that is not always ideal, is the type of surface existing on the inside of the pipe upstream from the differential pressure producing device. It is often rough and the cross section is not truly cylindrical. These conditions can be overcome by boring the pipe for five to ten diameters upstream. Because of the harmful and uncertain effect of pipe roughness upon the discharge coefficient and the expansion factor, when the diameter ratio (β) is large, it is advisable to limit the value of β to a maximum value of 0.75.

The over-all error of the measurement of flow rates by such apparatus equals the square root of the sum of the squares of the partial possible errors, such as those relating to (1) the tolerances given for the discharge coefficient (K), (2) those for the expansion factor (Y), (3) the errors of (K) and (Y) due to pipe roughness, (4) the density of the fluid, and (5) the measurement of the differential pressure. It is doubtful if the over-all error can be reduced below 1.5 per cent even when exercising the utmost care in machining the restricting device to the prescribed shape and following the present rules set up for making such measurements.

The three types of primary devices have distinctly different characteristics regarding the over-all loss of head that they create in the line, the venturi tubes creating the least, and the orifice plate the greatest. That part of the differential pressure developed for metering purposes that is not recovered as static pressure, when the stream of fluid finally fills the pipe on the downstream side of the device, varies with the diameter ratio (β), as shown in Table I.

Table I—*Per Cent of Metering Head Lost Thorugh Primary Devices.*

Diameter Ratio, β	Venturi Tube (with long diffuser)	Flow Nozzle	Orifice Plate
0.25	14	88	92
0.50	11	60	72
0.75	11	33	46

The over-all head loss through such devices and its effect on pumping power requirements may need to be seriously considered in permanent installations.

For a given (1) rate of flow, (2) differential pressure, and (3) size of pipe line, the throats of a venturi tube and a flow nozzle will be of approximately the same diameter, whereas the diameter of the hole in an orifice plate will be approximately 20 per cent larger. It is larger because the minimum pressure is dependent upon the maximum velocity which exists a short distance downstream from the orifice at the vena contracta where the stream is smaller in cross section than it is when passing through the orifice. This condition explains also why the discharge coefficients, which are used in the formulas involving actual throat diameters, are much smaller for orifice plates than for venturi tubes and flow nozzles.

As the amount of data on discharge coefficients available is greatest for orifice plates, less for venturi tubes, and least for flow nozzles, their status will be discussed in that order.

Orifice Plates

The recent A.S.M.E.-A.G.A. researches on orifice plates supply quite complete information on the coefficients of discharge for thin-plate orifices in pipes of various sizes and for various arrangements of pressure taps. Most of the data worked up so far apply to the taps located about one pipe diameter upstream and at the vena contracta.

The I.S.A. Rules include complete information on the use of quite similar orifice plates, but with pressure taps located adjacent to the orifice plate, which arrangement is seldom used with American orifice plates.

The comparative advantages of the orifice plate are cheapness of manufacture, ease of installation in existing pipe lines, and the large differential pressures developed which increase the accuracy of measurement by manometers during acceptance-test flow rate measurements.

There are certain comparative disadvantages in using orifice plates; namely, large over-all head loss, large differential pressures which require recording instruments with high differential pressure capacity in commercial metering, and difficulty of installation between high-hub flanges in high-pressure pipe lines due to the inability of locating the low-pressure tap opposite the vena contracta.

In standardizing orifice plates, specifications are given for the following details: thickness of plate, length of cylindrical bored section of orifice, sharpness of inlet square edge, angle of bevel on downstream face, and the location as well as the size of pressure taps. The preferred locations of the pressure taps are one diameter upstream for the one and opposite the vena contracta for the other.

The most authentic and comprehensive discharge coefficients for orifice plates in America are those determined experimentally by A.S.M.E. and A.G.A. For each pipe size they vary with the diameter ratio (β) and the Reynold's number ($\mathcal{R}$). For a given value of β the data on discharge coefficients can be safely extrapolated in the direction of higher values of $\mathcal{R}$, but should not be extrapolated to lower values of $\mathcal{R}$.

In the I.S.A. Rules, the discharge coefficients apply to a somewhat similar type of sharp-edged orifice, but for an entirely different arrangement of pressure taps. The coefficients are presented in curve form, varying with only β and $\mathcal{R}$. No distinction is made for variations in pipe size. It is difficult to say if such conditions actually exist with this arrangement of pressure taps adjacent to the orifice plate or if the specified tolerances on the coefficient curves include such variations. Above certain values of $\mathcal{R}$, the coefficients are shown as constant, whereas the American investigations with the different arrangement of pressure taps indicate that the coefficient continues to decrease as $\mathcal{R}$ increases.

The I.S.A. Rules include also tolerance increments to be allowed for dullness of inlet edge of the orifices and for roughness of the pipe.

Venturi Tubes

The published data on venturi tubes are very meager regarding shapes and coefficients. The A.S.M.E. Fluid Meters Research Committee has published some data furnished by the manufacturers, but they are not nearly so comprehensive as those available on orifice plates.

The comparative advantages of venturi tubes are: the tube forms a part of the pipe line, thus enabling the manufacturer to control the perfection of the pressure taps as well as the diameter and the roughness of the inlet section, and the small over-all head loss, which is less than that of either of the other two devices. The amount of over-all head loss can be controlled within certain limits, when designing the tube, by the size of the included angle of the outlet diffuser cone, which in turn affects the length of the diffuser for any given value of β. The percentage of metering differential pressure that is lost in venturi tubes with various lengths of diffuser cones is shown in Table II.

Table II—*Percentage of Metering Head Lost in Venturi Tubes with Different Lengths of Diffuser*

Diameter Ratio, β	Long Diffuser	Short Diffuser	No Diffuser
0.25	14	75	90
0.50	11	32	62
0.75	11	17	36

The comparative disadvantages in using venturi tubes are: high cost of manufacture, difficulty of getting the intermediate flanges of the tube assembly to match the pressure standards used in the design of the pipe line, and the necessity of cutting and reflanging pipe when installing a tube in an existing line.

Little has been done by any technical organization to standardize the shapes and coefficients of venturi tubes, as there has been little occasion to install such devices temporarily in order to measure rates of flow of fluid for acceptance tests. Most venturi tubes are permanently installed with recording and integrating devices. In cases where extremely high accuracies are required, the manufacturer has the individual tubes calibrated in a reputable hydraulic laboratory and builds the secondary devices to match the calibration of the tube.

Flow Nozzles

Little comprehensive data on shapes, effect of pressure-tap locations, and coefficients of flow nozzles have been published in America.

In the I.S.A. Rules the profile of the flow nozzles and the arrangement of pressure taps is entirely different from that used in this country, although the data are quite complete and are based on comprehensive tests.

The comparative advantages of the flow nozzle are: less expensive than the venturi tube although more expensive than the orifice plate, can be installed without much difficulty in existing pipe lines, throat section can be extended so that the low-pressure tap can be located beyond the hub of the pipe flange, and where desired, a flow nozzle can be incorporated in welded pipe lines.

The only disadvantages of using flow nozzles are that they are more expensive than orifice plates, and that, at the present time, fewer data on coefficients are available. The latter disadvantage will be overcome when the researches now being conducted by the A.S.M.E. and the National Bureau of Standards are completed.

The profile of the nozzle used in this country has a longer radius of approach to the cylindrical throat than does that specified by the I.S.A. Rules. Some authorities feel that the abruptness of the approach in the I.S.A. nozzle may prevent the complete filling of the throat with the fluid, whereas the long-radius approach of the American nozzle is believed to prevent such a condition.

The preferred locations of the pressure taps with the American nozzle are in the pipe walls one diameter upstream and just ahead of the discharge end of the nozzle. There seems to be some doubt in this country regarding the reliability of the pressure readings obtained with the taps in the corner at the inlet and at the corner of the recess between the nozzle outlet and the downstream pipe, specified in the I.S.A. Rules.

In conclusion, it can be said that (1) comprehensive data on the design and use of orifice plates to measure rates of flow of fluids in pipes with a high degree of accuracy are now available, (2) comprehensive data on venturi tubes are lacking, and (3) that data on the design and use of flow nozzles as comprehensive as those now available on orifice plates will be forthcoming when the researches by A.S.M.E. and the National Bureau of Standards are completed.

Introducing Accounting

Prof. J. R. Bangs, M.E. '21

G. R. Hanselman M.E. '22 C. I. Millard E.E. '26

Cradled in mathematics, with algebra as its twin, nutured by the great universities of the middle ages, this "Method of Venice" has become to-day an indispensible tool of modern enterprise. Sometimes difficult to comprehend, its fundamental technique may be simplified through the use of diagrams.

A man with a secret, mobile face walked past the doorkeeper of his Paris apartment, mounted the stairs to his room and shot himself. The next day confusion reigned in the financial world; stocks tumbled and bankers trembled. A week later there journeyed from Paris to Stockholm a group of gentlemen from the firm of Price, Waterhouse and Company. Three weeks later they issued their report; missing securities, false entries, grossly overstated profits, fraud.

The dead man was Ivar Kruegar, whose name filled headlines the world over. The gentlemen from Price, Waterhouse and Company were certified public accountants. Accountants are erroneously conceived by the general public as old men with green eyeshades, who sit on high stools and add up other people's figures—to all intents and purposes a secret fraternity buried beneath journals and ledgers. Yet if we dig beneath these books as the gentlemen from Price, Waterhouse and Company dug into the books of Ivar Kruegar, we shall find not human adding machines but the youngest, least-known and most reasonable of professions. Certified by state boards after pitiless examination, this rapidly growing profession boasts some 12,000 members whose duty it is to investigate the chief facts of business enterprises and to rearrange those facts in true and logical order. This race of factual watch dogs guard the corporation and its stockholder alike, substantiate the truth of the reports of two-thirds of the companies listed on the New York Stock Exchange, determine the bases of many great mergers, and vouch for the earnings per share of the stocks you buy.

Performing these and a multiplicity of other functions, accountancy also ranks as the only profession, other than law, which is allowed to plead before the Board of Tax Appeals in Washington, an august body which has the standing of a U. S. Court.*

But to attain so honored and respected a position has taken centuries; in fact some form of record keeping has been a part of our commercial fabric since property rights were first crystallized. When trade was revived in the 12th and 13th centuries, following the chaotic conditions which existed during the dark ages, Italy played an important part in the development, and there grew in and about Venice a system of account keeping known as the "Method of Venice."

Embodying the fundamentals of "double entry" upon which all modern accounting is founded, this "method" was duly recorded for posterity by a Franciscan monk named Luca Paciolo. Paciolo, famous for his writing and holding academic credentials of the highest order, was an important if not a great mathematician. In 1494 seeking

*An abstract of the introduction to Fortune's story of "Certified Public Accountants." (June 1932; page 63.)

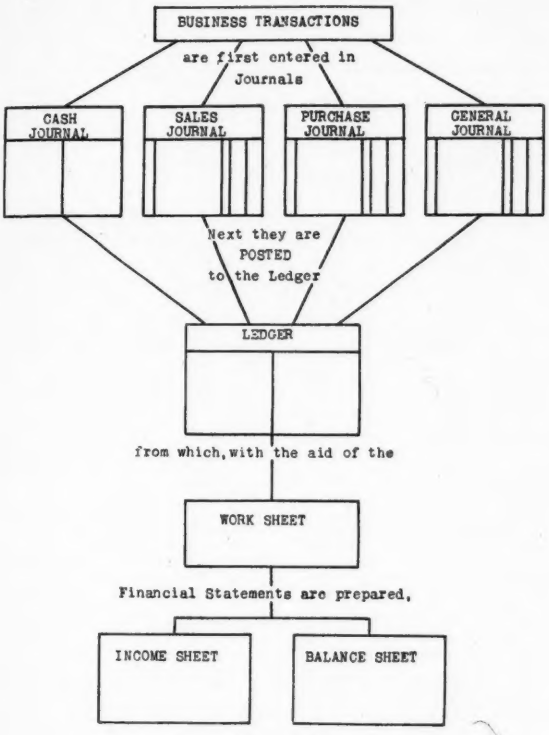

FIGURE 1

to summarize the existing knowledge of mathematics of that day, he published his classic "Summa de Arithmetica, Geometria, Proportioni, et Proportionalita" or more simply "everything about arithmetic, geometry, and proportion." Not only was this the first printed work dealing with algebra, but it also contained the first writings on bookkeeping which Paciolo disposed of in 37 short chapters under the title of "De Computis et Scripturis." And, it is only as we evaluate these writings in the light of present day methods that we can realize our debt to the tradesmen of the middle ages and to—Paciolo; for although he invented none of its principles, his first presentation contained the essential factors of bookkeeping and accounting as we know it today.

The real growth of accounting unquestionably took place in the 20th century, and there are two major reasons for it. The *first* of these is the tremendous expansion of American industry with its gigantic manufacturing plants, woven together in many instances through huge mergers that require the most intricate and exacting type of accounting; the *second* is the rise of federal and state income tax requirements which forced individuals and corporations alike to engage in a more and more complicated accounting technique in order to safeguard their earnings. This technique, of course, may be not too involved in a simple enterprise; but the dazzling array of holding companies, parent companies and subsidiary companies with their diversified financial structures and only too frequent reorganizations have created accounting problems with which only the most penetrating and imaginative minds can cope.

The machinery of American business has expanded so rapidly that former definitions of assets, liabilities, capital, surplus, reserves, profits, etc. in all their many subdivisions and ramifications have become questionable and sometimes invalid. In other words, "the giant has outgrown his ability to speak intelligently about himself, and it becomes, therefore, the task of the professional accountant to discover, define, and speak the words that describe him." *Accountants say that accounting is the mother tongue of business; not an exact mathematical science, but a growing debatable living language.

BOOKKEEPING AND ACCOUNTING.—In the treatment of the subject in these introductory pages, no sharp distinction has been drawn between bookkeeping and accounting. Yet there are important differences, as the definitions made available in a "Preliminary Report of a Special Committee on Terminology of the American Institute of Accountants" reveals so clearly.

On page 29 of this report, bookkeeping is described as: "the work of recording systematically the transactions of an undertaking so that the profits, losses, assets, and liabilities may be ascertained with the minimum of work and the maximum of correctness." The ascertainment of profits includes cost finding. The chief purposes of bookkeeping are defined by Lisle as follows:

(1) To record the effect of any one transaction.

(2) To record the combined effect of all transactions within a given period so that the financial position of the concern at the end of the period may be ascertained.

The report defines accountancy (the profession of accounting) as: "the profession dealing with methods of recording business transactions with the correct statement of financial affairs, with the guidance of business men in interpreting their accounts, and with the application of sound accounting principles to future developments of business, as in the preparation of budgets."

Another speaks of accounting principles and of bookkeeping methods thus: "Accounting is a matter of theory and principle, while bookkeeping is a matter of technique. And yet as a practical matter, they cannot be dissociated; the two must be taught and understood together. The accounting principle cannot be fully understood without a knowledge of the bookkeeping method of applying it. And the bookkeeping method cannot be fully understood without a knowledge of the accounting principle which determines and interprets the facts to be recorded.**

The objective of accounting is the statement of financial affairs in such a manner as to give due effect to every material factor, making available the light that past accounts can give to assist in planning for the future. It consists of two processes: synthesis, such as is used in building up and designing accounts; and auditing, the ob-

*Fortune Magazine June 1932, page 95, "Certified Public Accountants."

**Finney, "Principles of Accounting," 1923, Chapter 1, page 2.

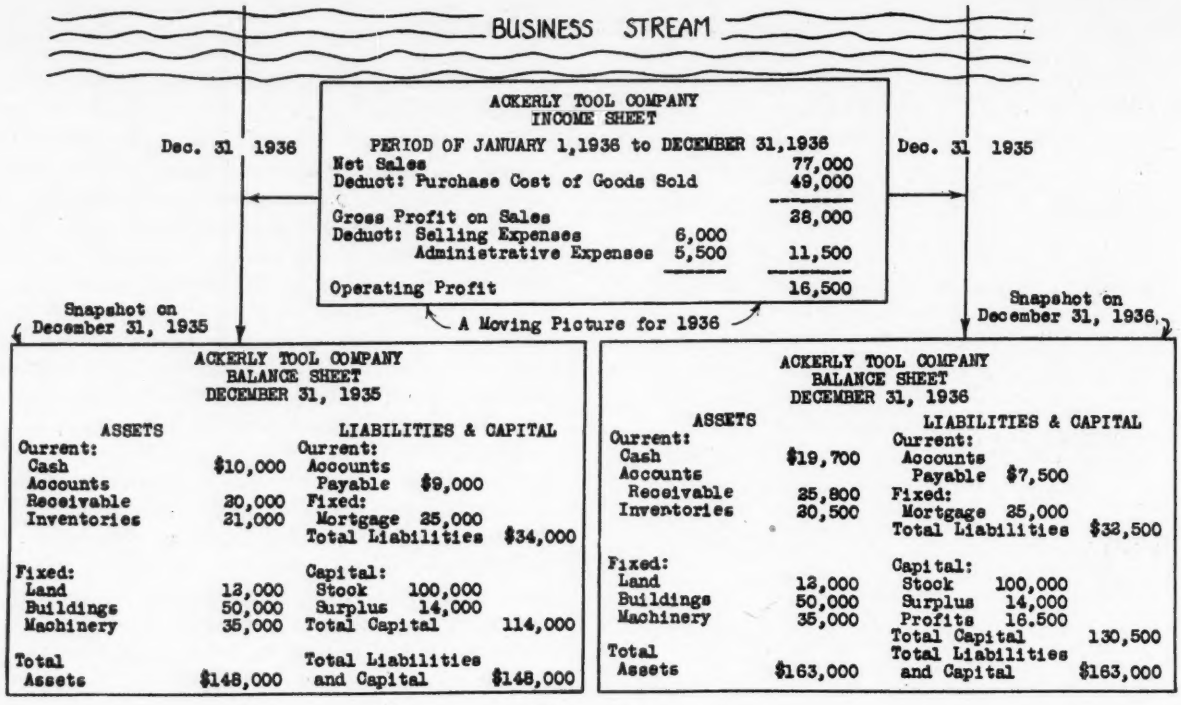

FIGURE 2

ject of which is to analyze and verify the results submitted.

The foregoing discussion emphasizes the idea that accounting is more inclusive than bookkeeping. It includes within its field the entire subject of recording and stating of facts in relation to the production, conservation, and disposition of values, no matter what the technical processes of enumeration or recording may be.*

This relationship may perhaps be remembered more easily by considering several simple analogies: a machinist is not a mechanical engineer because his work does not call for a training in mathematics, physics, and mechanics so essential to the engineering profession; a contractor is not an architect for similar reasons; nor by the same token is a stone cutter a sculptor. The accountant likewise deals with problems of a higher order; his functions are largely based upon the processes of reason and imagination by means of which he interprets the routine number result of the bookkeeper for the purposes of management control.

DIAGRAM OF ACCOUNTING PROCEDURE.—To the uninitiated, accounting theory and practice seems steeped in mystery and entangled in detail. This need not be so; for teaching experience strongly indicates that certain phases of accounting theory, as well as many of the standard procedures, may be presented in simplified form by the appropriate use of diagrams. For example, you may have a reading knowledge of the financial statements of a business enterprise; yet you may not have the slightest conception of the procedure involved in obtaining them. The diagram shown in Figure 1 aims to solve this difficulty by presenting a chart of procedure which reads from the original business transactions at the top to the statements at the bottom. Here briefly is an overall picture of accounting procedure.

In the Cash Journal, Sales Journal, Purchase Journal and General Journal are recorded the business transactions in chronological order; that is, day by day, as they occur. Experience has shown that it is necessary to assemble these transactions under appropriate account headings in one general book. This book is called the Ledger, and the process of carrying the original entries from the books of daily record to the Ledger is called posting. When the number of accounts tends to make the use of one general ledger unwieldly, subsidiary or auxiliary ledgers are often used.

To obtain the financial statements, accounting tools known technically as the trial balance and the work sheet are applied to the ledger. Their use enables the accountant to separate and adjust the various ledger accounts and to arrange them in statement form. Thus are obtained the true objectives of the accounting procedure—the Balance Sheet, and the Income Sheet.

However, the fundamental concept of these statements is not always clear. You are apt to confuse them if you do not grasp at the outset the purposes for which they are designed. The Balance Sheet is a picture of the financial structure of the business at a particular instant of time: the Income Sheet is a record of the financial progress (profit or loss) of the organization. This idea may be charted as shown in Figure 2 by considering a business as a flowing stream.

*See "Elementary Course in Accounting," Pace Institute.

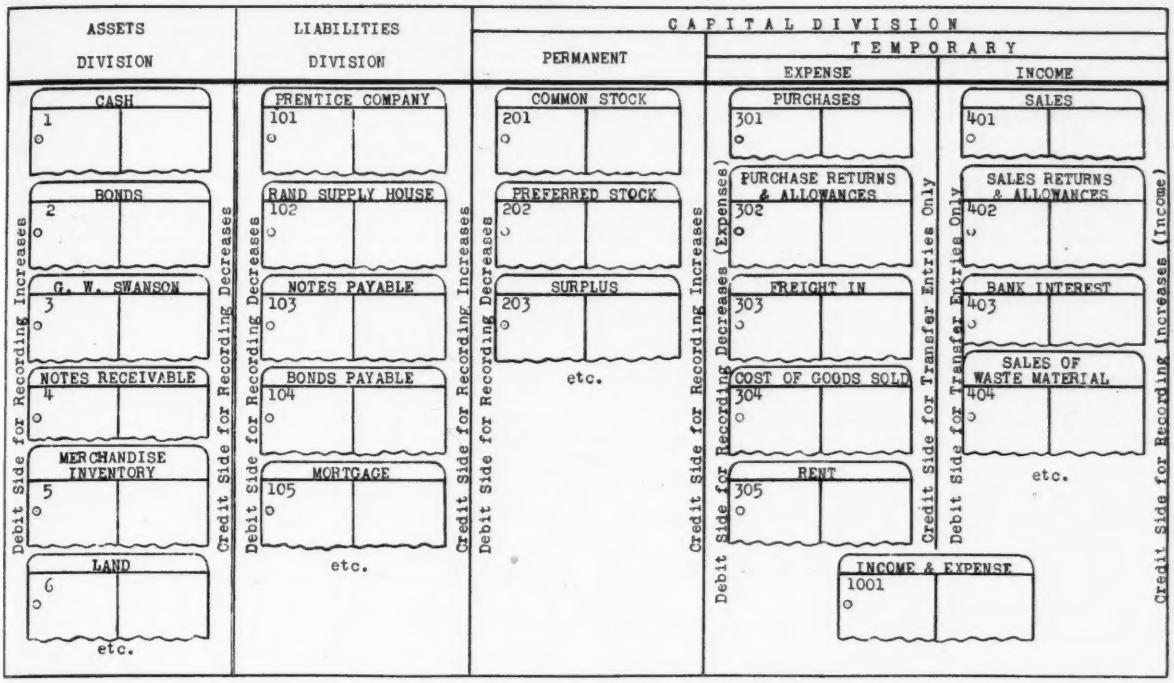

FIGURE 3

The Balance Sheet, it will be observed, is a cross section of the stream at a particular point, while the Income Sheet measures the progress between two such points In other words, the Balance Sheet as of December 31, 1935 gives the status quo of the business at that particular time; and similarly the Balance Sheet as of December 31, 1936 performs an identical function for that particular date. However, (and this point is most significant) the very static nature of these sheets limits their usefulness, for it is evident that many things may happen from one year to another that balance sheets by their very nature cannot fully portray. As a stream flows either smoothly or roughly from one point to another, so likewise does a business encounter smooth and rough sailing as it progresses through its fiscal period (usually a year although it may be any convenient period). To show the income and expense (and the resulting profit or loss) due to the variations of business fortunes, a statement generally known as an Income Sheet is used to reflect these facts. This sheet is a statement showing the progress (or lack of it) made in passing through the fiscal period. It should be visualized as dynamic—a rushing, whirling portion of the business stream summarizing all incomes, recording all expenses and computing therefrom the resulting profits or losses.

The Income Sheet may further be considered as a sort of connecting link between undistributed earnings at the beginning and at the end of a fiscal period. As Cole in his excellent text "Fundamentals of Accounting" has said: "The two balance sheets give the terminals of the journey (Start and Finish) and the income and expense sheet gives some of the details of the journey itself."

Since the Balance Sheet is a statement of financial *position,* and the Income Sheet one of *progress,* some of the more prominent writers in the field compare the Balance Sheet to a *snapshot* of the business and the Income Sheet to a *moving picture.*

The two statements are complementary; neither sheet alone gives a complete picture of an enterprise. Consequently they are usually prepared and presented as one unit.

On the other hand there are those who, looking at the Balance Sheet from another angle, believe that to call it a snapshot of the financial condition of the business is a false conception. Illustrative of this point of view is the following quotation from "Is Value an Accounting Concept" by Maurice E. Peloubet in The Journal of Accountancy, March 1935, Volume LIX, Number 3, pages 203-205.

"In the not very distant past, when accounts were first being subjected to really thoughtful analysis, there was a widespread opinion, which is still held in some responsible quarters, that the balance sheet was "static" and the income account (sheet) was "dynamic." In other words, the balance sheet was thought to be an instantaneous photograph of a business at a particular moment of time, and the income account (sheet) was construed as a sort of symbolic, arithmetical narrative of the happenings in the business between two of the "static" points. The concept, I think, is fundamentally false. It has a certain superficial appearance of truth, because it could have been

(*Continued on page one twenty-three*)

THE CORNELL ENGINEER

PUBLISHED MONTHLY DURING THE COLLEGE YEAR

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EDITORIALS

COPYING

The end of the term has come and gone, with its usual last minute rush of prelims, reports, and problems—things which should have been done long ago, but which, for some reason, or other, weren't. In the midst of the press of all these things, we often find it necessary to make substantial reference to the work of more foresighted brethern who have theirs completed, sometimes to the extent of a verbatim reproduction. And most of us usually stop to wonder whether we are doing just the right thing by handing in someone else's work as our own. It is no question at all to the faculty. They are thoroughly and completely opposed to everything that savors of copying. But so far as the rest of us are concerned, there may be some question as to whether or not there are many instances where such tactics are quite justifiable.

We run up against a great many problems and reports in which there is nothing with which we are not more or less familiar. There is no question but that we could work them out correctly, without any great mental effort if we had sufficient time in which to do it. They are time-consuming, but not difficult. There is little to be gained by working them out completely. In many instances, we can obtain whatever of value there is in working them out just as well by following the reasoning of someone else as we copy the work. If, then, by such copying, we are enabled to get the work in on time when we would otherwise not be able to do so, it seems to us that we are justified in using the work of another. In this, as in all things, circumstances govern cases.

Editor's Note: The feeling expressed above is very prevelant among the students in general, and tends to defeat the purpose of these reports. A later issue of the Cornell Engineer will contain an article on the general topic of report writing, discussing it from the viewpoint of the practicing engineer. In short, however, each report offers a new problem in the presentation of data, and an excellent source of practice on general organization. An engineer in the field writes reports, not for the purpose of proving that he knows the subject, but condensing and summarizing lengthy material for reference of other men. It is the ability to summarize briefly and accurately, so that others may understand with a minimum of effort, that marks the successful engineer.

—o—

ANOTHER MERGER

Recently, several mergers and reorganizations have been proposed to make the engineering college a more unified group; to fill any gaps existing between the various schools. Some of these plans have been accepted and are functioning. Others are still under consideration.

There is one consolidation which has not, to our knowledge, been suggested, and we would like to submit it for consideration. This plan consists of the consolidation of the Engineering Libraries.

The advantages of such a movement should, of course, be considered. An important advantage is that the consolidated library would be able to be open in the evening. If the Sibley, Franklin, and Lincoln Libraries were to consolidate, the help required to operate this new library in the evenings, as well as during the day, would be no more than is at present required for their individual operation.

Another advantage is that a consolidated branch would be able to economize on periodicals as duplication could be done away with. This money could be used for more periodicals or books. The overhead required to operate three individual libraries is obviously greater than the overhead which would be required to operate a single, consolidated library.

There are several questions which would have to be

investigated before such a move could be made. One of these is whether the use of such a consolidated branch would warrant the trouble necessary in its organization. Another question is the matter of where this consolidated branch could be situated. Offhand it would seem that room might be found in the present Sibley branch to house it. However, this matter would require some research.

It seems rather feasable that such a consolidation as suggested here, would be advantageous. It is at least worth investigating.

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"HOOVER DAM"

The editorial staff of the CORNELL ENGINEER notes with interest the recent resolve of the American Association of Engineers to favor the maintainence of the name "Hoover Dam" to the more recently suggested and more commonly accepted "Boulder Dam". It is altogether fitting that recognition be given to the man who was to a great extent responsible for the construction of an engineering project of such magnitude.

It has been common practice for several administrations to name large projects of this type after the incumbent President, as is witnessed by the Coolidge Dam and the Roosevelt Dam. Not only was the construction started on this dam during the administration of President Hoover, but as a prominent engineer, Herbert Hoover headed the committee which investigated the feasibility of this project. In this position, he sold the practibility of such a dam to Congress, and later as President, negotiated with agencies interested in the power development.

Through the work that Hoover did previous to his Presidential election, as an eminent engineer he merits the honor of this distinction being made him. It is a mere coincidence that construction was started during his administration, so that custom should concede him this honor. Should the title be officially changed after all this, besides being an unearned rebuff, it would be irony itself.

—o—

SOCIALIZING ENGINEERING

If the activities being sponsored by the student engineering societies are any indication, the engineer is becoming quite a sociable fellow. This school year has seen the inauguration of several new social functions, and the sponsors deserve commendation.

The first event to be held was the EE Smoker, sponsored by Eta Kappa Nu. The juniors, seniors, and faculty in EE got together, and spent most of an evening getting acquainted.

Shortly after the EE affair, the two honorary CE fraternities Rod and Bob, and Pyramid held a Frosh Smoker. This gave the freshmen an opportunity to get acquainted with the faculty and upperclassmen. In December, the Student Council sponsored an Engineer's Ball. This gave us a chance to give the university an impression different from the traditional one of unshaven men in corduroys and sweaters with slipsticks projecting from various pockets.

INTEGRATION

In the organization of the curriculum of the College of Engineering, it is deemed advisable that every Freshman be subjected to the same fundamental training in the basic courses such as Physics, Mathematics, etc. Following the sound Gestalt Theory of Psychology, it is supposed that at the end of the first year the individual student will differentiate from the entire dynamic field of Engineering that specialized type of Engineering he feels best fitted for and most interested in,—hence his choice of one of the various Schools—Civil, Electrical, Mechanical, etc. His Sophomore year is again spent in a common training as presented in the light of the differentiated field and according to its special needs. In his Junior and Senior years the student differentiates his course of study to a high degree of specialization, with his major and minor fields. By this time, sad to say, in most cases not only has he failed to acquire any conception of the field of Engineering in its entirety, but he even lacks a definite understanding of the particular phase of Engineering encompassed by his own School.

The attempt at integration made by the Introductory Lecture course is weak and meaningless. The Freshman, having so little understanding of the nature of any part of Engineering, can comprehend practically nothing of so general a discussion of Engineering as therein presented. It seems most urgent that at the end of the college training some means were presented to the student of organizing his vague conceptions of Engineering, and in the form of a series of lectures, he be given a picture of Engineering as an integrated whole, with all parts in their proper relationship, each playing a role as significant as every member of any firm, well designed structure.

—o—

A FRESHMAN PRIZE

It is the custom of many engineering schools, as in our School of Civil Engineering, to give a prize to the most outstanding freshman in each class. This is usually given by Tau Beta Pi or other similar honorary engineering societies, which seem to be so plentiful throughout our own engineering school. The prize might even be given by the College of Engineering, and prove a use for that mysterious Sibley tax which we so cheerfully paid in our frosh year. In most schools a slide rule is given, but that is out of the question at Cornell since by the end of the first year almost all the engineers have already purchased these instruments. Why not give a good handbook such as Marks, or a similar one, which few engineers buy before their junior year? Such a book proves invaluable in mech lab. as well as other forms of advanced engineering.

The awarding should, of course, be based mainly on scholarship, but other things should also be taken into account. Such a prize would create a great deal of interest in studies, and be a very fitting reward for an outstanding student engineer, who for a year has made an excellent record. It would also tend to create constructive competition between the various schools of engineering as well as between the students themselves.

ALUMNI NOTES

'16 ME—L. R. Lohr on the first of the current year undertook the duties of President of the National Broadcasting Company. Previous to this work, he was in charge of the Chicago "Century of Progress" having accepted the position of General Manager in 1929.

'31 ME—S. N. Bean is doing time study, cost estimating, and development work in the Purox division of the Oxweld Acetylene Company, Los Angeles, California.

'31 ME—R. M. Bentley is chief engineer for the Commercial Shearing and Stamping Company, Youngstown, Ohio. He lives at 248 Norwood Avenue, Youngstown.

'31 ME—H. W. Boyd, Jr., is assistant secretary and director of the General Shoe Corporation, Nashville, Tennessee. His address is Iroquois Avenue, Belle Meade, Nashville.

'31 ME—G. N. Cole has a position assisting the chief draftsman of the Pratt and Whitney Aircraft Company, East Hartford, Conn.

'31 ME—W. S. Corbin is an assistant development engineer with the Scott Paper Company, of Chester, Pa.

'31 ME—S. L. Elmer, Jr., writes that he is teaching secondary school mathematics in the Rye Country Day School, Rye, N. Y., and taking graduate work in mathematics at Columbia University during the summers.

'31 ME—J. V. D. Eppes is doing research work on laboratory "cracking" units for the Texas Company, Port Arthur, Texas. He lives at 3417 7th Street, Port Arthur.

'31 ME—A. R. Erda is working at brewing technology and engineering for the Schwarz Laboratories, Inc., 202 East 44th Street, New York City. He is also an instructor in practical brewing at the United States Brewers Academy. His home is at 25 Prospect Place, New York.

'31 ME—F. C. Fay is in air conditioning work with the York Ice Machinery Corporation, in their sales department, at 42nd Street and 2nd Avenue, Brooklyn, N. Y. He lives at 40 De Koven Court, Brooklyn.

'32 ME—H. N. Chandler is assistant operating foreman of the new Havoline Motor Oil plant of the Texas Company, Port Arthur, Texas.

'32 ME—J. D. Colman is with the Hospital Council of Essex County, Newark, New Jersey. His work consists of coordinating the work of the non-profit hospitals in the county to effect greater economy in their operation. He makes his home at 188 Claremont Avenue, Montclair, N. J.

'32 ME—R. S. Craig is selling White motor trucks for Brewer and LeBlanc, Inc., Jersey City, N. J. He lives at 41 Roosevelt Road, Maplewood, N. J.

'32 ME—J. B. Crommelin is with the Prudential Insurance Company, in their work dealing with loans on properties. He is temporarily located at Webster, South Dakota.

'32 ME—Also in the insurance business is A. D. Davis, who is with A. J. Davis and Company, of Chicago, who are insurance brokers specializing in coal mining properties. He lives in Evanston, Ill., at 114 Kedzie Street.

'33 ME—R. S. Babcock is doing research engineering as applied to oxyacetylene processes for the Oxweld Acetylene Company, Newark, N. J. He lives at 115 West 7th Avenue, Roselle, N. J.

'33 ME—E. H. Bleckwell is in the industrial engineering division of E. I. du Pont de Nemours and Company. He is also teaching advanced algebra at the Bridgeport Engineering Institute. He lives at 63 Fairlawn Ave., Bridgeport, Conn.

'33 ME—D. T. Braymer is an assistant editor of the "Electrical World," a McGraw-Hill publication. He resides at 512 Park Avenue, West New York, N. J.

'33 ME—H. A. Dreyer is a foreman in charge of making soap chips and flakes for Procter and Gamble, at Chicago. He lives at 1252 Norwood Street, Chicago.

'33 ME—Out in sunny Hawaii, D. R. Fair is manager of a branch of the Von Hamm-Young Company, Ltd., of Honolulu, automobile dealers. He is located at Wahiawa.

'34 ME—Irving Taylor is a student engineer with the General Electric Company. He lives at 1279 Lowell Road, Schenectady, N. Y.

'34 ME—W. P. Wilke, III, is chief of material in the construction of a cold strip steel mill for the Bethlehem Steel Company, at Sparrows Point, Md.

'34 ME—J. G. Wills, Jr., is the engineer in charge of the metallurgical laboratory of the Blaw-Knox Company, Blawnox, Pa.

'34 AE—Delbert P. Rose is engaged in the selling of steam shovels and coal mine supplies for the General Machinery and Supply Co., Pittsburgh, Kansas.

'34 AE—Starbuck Smith, Jr., is studying law at the University of Cincinnati Law School. He intends to practice law in Cincinnati when he finishes his course.

'34 AE—Bruce Taylor is in the cost department of the Herne Electric and Manufacturing Company, of Cleveland, doing time study work.

'34 AE—G. R. True is with the Detroit Lubricator Company, doing laboratory work in the design and development of new products in the heating and refrigeration control field. He lives at 1944 Atkinson Avenue, Detroit, Mich.

'35 ME—Fred A. Giesecke is a student foreman in the Corn Products Refining Company, Pekin, Ill., doing

various kinds of work to learn the process.

'35 ME—George W. Jacobus is taking a training course with the Bausch and Lomb Optical Company, Rochester, N. Y. He lives at 165 Harvard Street, Rochester.

'35 ME—Richard L. Katzenstein is with the Bethlehem Shipbuilding Corporation, Ltd., at Quincy, Mass., running acceptance tests on various types of equipment.

'35 ME—Christian R. Kemp is a test engineer with the Ingersoll-Rand Company at Phillipsburg, N. J.

'35 ME—W. C. McClennan is with the Johns Manville International Corporation, New York City, training for export work in the sale of their products. He lives in Elizabeth, N. J., at 810 North Broad Street.

'35 AE—J. P. Kittredge is in the maintenance department of the tin mill of the Republic Steel Company at Warren, Ohio.

'35 AE—J. P. McAuliffe is a credit investigator in the Rochester branch of the Hooper-Holmes Service Bureau, of New York City.

'35 AE—Leonard G. Martien is doing estimating on electrical construction work in the Martien Electric Company, Cleveland, Ohio. He lives at 2917 E. Overlook Road, Cleveland Heights.

'35 AE—Robert M. Maust is temporarily with the U. S. Shipping Board. He is a supervisor in charge of the construction of fire-proof bulkheads for a ship which will be set afire and tests made for the new steamboat inspection rules.

'35 AE—C. W. O'Connor is a sales engineer with the Ingersoll Rand Company. He lives at 142 E. 37th Street, New York City.

'35 EE—A. R. Longnecker is in New York working for the New York Telephone Company. He is doing underground lines work at the present time, in a schedule designed to cover all the branches of work handled by the company.

'35 EE—N. C. Einwechter is taking a two years training course with the Philadelphia Electric Company. The course covers six months in each of, sales, engineering, operating, and service and public relations. He lives in the Kenilworth Apartments, Germantown, Philadelphia, Pennsylvania.

'35 EE—F. W. Fink is doing research work on the corrosion of brass, a problem connected with boiler tubes, under the tutelege of Dr. V. R. Evans at Cambridge University, England.

'35 EE—J. DeW. Willcox is working in the A. C. Engineering department of the Elliott Company, Ridgeway, Pa. He is studying in each of the various departments that is in any way connected with sales.

'35 EE—C. H. Scutt is with the Ford Instrument Company, Long Island, New York where he is doing electrical and mechanical testing of instruments manufactured for the Navy.

'35 EE—W. E. Rummler is a student engineer with the Otis Elevator Company. This entails two years of practical work at production and administrative methods.

STRESS and STRAIN

It seems the boys at Psi U have a lot of good, clean fun with Sandy Wahl's amplifier,—like the time it was hidden in the cedar chest in the dormitory, and along about three A. M., this chest began emitting nerve-shattering groans and shrieks. The idea has, definitely, possibilities.

* * *

Note to Editor: If we haven't given you enough material to fill the space, fill the rest of it with how we haven't had time to write it on account of being so busy drinking at the Dutch and taking in the latest shows in The City—the way the columnists who write *The Berry Patch* and *Variety* do.

* * *

From the country comes this tale of the great quest for the laziest man in the county. The committee finally reaching the decision, started out to the home of farmer Lane, about three miles up the pike. He was found lying in the shade in front of his house, and it was here that he was informed of the honor which had befallen him. However, after the presentation speech was made and the silver jack-knift proferred, silence reigned, with farmer Lane still lying. Finally Elmer blurted out with "Ain't you got nothin ta say, John" to which the answer was, after an even longer silence, "Pututinmapokut."

* * *

We don't suppose this gem will get printed—the editors have been "unable to find room for it" in the last three issues—but what the hell, here it is:

Question: "What is a slide rule?"

Prompt and scintillating response: "Never slide with new pants on."

The *California Engineer* is the culprit.

* * *

We have been taking Prof. Switzer's course in advanced mechanics off and on for several years now, and we'd always thought the professor liked us. But no. Maybe he got tired of our face. Anyhow, he handed back our last two prelims this term with marks high enough to insure our not taking the course again, and wrote across them in red pencil, "Hot Dog!" and "Are we glad?"

(*Continued on page one hunderd twenty-four*)

COLLEGE NOTES

STUDENT A.S.C.E.

The student branch of the American Society of Civil Engineers held its annual New York inspection trip on January 3. Conducted by Homer R. Seely, '19, the party of fifteen men made a thorough investigation of the structure and processes involved in the new sewage disposal plant at Wards' Island.

The trip, by boat to the island, landed the men at the northern end, where the new $33,000,000 sludge plant is located. This plant is capable of handling one hundred and eighty million gallons of sewage per day. This capacity is sufficient for a city of two million.

An engineer from the department of sanitation accompanied the tour around the plants, pointing out the process involved in the plant operation. The sewage is pumped from undersea tunnels into preliminary settling tanks on the island. From there it is pumped to aeration tanks, where it comes in contact with activated sludge, and passes through galleries for a period of about four hours. The last stage is another set of settling tanks from which the clear effluent drains into the East River and the sludge is removed by barges.

—o—

STUDENT A.S.M.E.

On Wednesday, January 15, Mr. W. H. Carson addressed the local branch of the A.S.M.E. on "Recent Developments in Color Photography." Mr. Carson, who is vicepresident and treasurer of the Dufaycolor Corporation, described methods used by Dufay and also Technicolor in the development of color film.

The Dufay color process was described as an additive process in which the light was broken down into the three primary colors: red, green and blue. These colors are placed on the negative in narrow bands and in this manner a great accuracy in reproduction is acquired.

Following the regular talk, Mr. Carson conducted an open forum, during which period the meeting was thrown open to questions from those in the audience interested in amateur photography.

The meeting was well attended by both members and guests. Over 200 were present.

—o—

NEW BOOK BY PROF. MACKEY

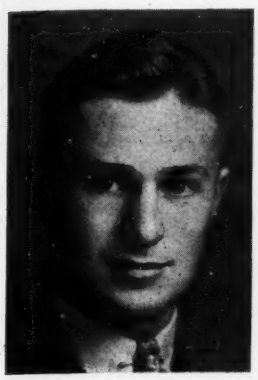
"Graphical Solutions", just published by John Wiley and Sons, is a book that had its origin in the material given in an elective course for several years in Sibley. The author is C. O. Mackey, assistant professor of heat-power engineering.

The material covered in the text is adequate for a well rounded course on graphical and mechanical computations and is intended for use in every branch of engineering. Chapters I through IV cover stationary adjacent scales, sliding scales and special purpose slide rules, network or intersection charts, alignment charts, and combinations of these solutions. Chapter V contains a discussion of the methods of finding the constants in non-periodic empirical equations to fit experimental data. There are 130 pages, 53 figures, and 135 exercises in the book.

Chapter II on slide rules is particularly novel because very little explanation has been given in engineering literature of the design and use of special purpose slide rules, i.e., slide rules that solve only one equation or formula. With slide rule blanks available, graphical scales for these blanks may be readily prepared, and many formulas in common engineering use may be represented or solved in this manner. This method of solution competes for adoption with the more familiar graphical methods exemplified in intersection or network charts and alignment charts.

This term, for the first time, Graphical Computations, 3P55, given by Professor Mackey, will be required of all sophomores in Administrative Engineering. The course is still offered as an elective to students in the other branches of engineering.

(*Continued on page one twenty-four*)



PRESENTING TWO MORE OF THE OUTSTANDING MEN ON THE ENGINEERING CAMPUS . . . . .

PERSONALITIES

HENRY STITES GODSHALL, JR.

As an administrative engineer, Hank enjoys most their special courses—money and banking, economics, business law. His main interest at Cornell is in making contacts and meeting all kinds of people. After graduation, he expects to enter the production end of engineering, and to work toward an executive position in some big corporation.

Hank feels that extra curricular activities are at least equally as important as studies, and are probably more important in later years. Scholarship, though, is the *sine qua non,* and he seems not to have neglected it, having won membership in Eta Kappa Nu, Kappa Tau Chi, and Tau Beta Pi.

Although he plays football and interfraternity basketball, Hank's favorite is track. He went to Europe with the track team, and bicycled through England and France. Travelling down the Rhine in a canoe, he and his companions found sleeping outdoors rather cold, and one of them turned in for the nite wearing his slicker, with stockings on his hands and his head tastefully wrapped in a towel. On that trip, it became apparent that their canoe wouldn't get them to Antwerp in time to catch their boat at Harve, so a passing coal barge was hailed, and the canoe hauled aboard. A slight difficulty appeared because the crew of the barge spoke only Flemish—and engineers are not noted for their linguistic ability. But the trip was highly successful—Hank reached America with fifty cents in his pocket.

Hank is best known as president of the Student Council. Although this means a great deal of work, he finds time to serve on the Board of Managers of Willard Straight and to be house manager and treasurer of his fraternity, Kappa Sigma. He is a member of Quill and Dagger, and president of Spiked Shoe and Aleph Samach.

One of the things he wants most to do is to make undergraduates realize the opportunities of cosmopolitan Cornell. He is working for increased friendliness on the campus and unified activities outside of fraternities.

LLEWELLYN WILLIS COLLINGS, JR.

At Cornell, Lew studied pretty hard his first three years—as witness his membership in Tau Bete, Eta Kappa Nu, and Phi Kappa Phi. His fourth year is being devoted chiefly to a variety of activities, and he's on the fence with regard to the relative value of activities and scholarship, but feels that scholarship is essential, and activities are valuable for keeping out of ruts.

Lew was chairman of the notorious Engineers' Ball, and states that he is delighted that the Junior Prom committee is advertising super-stupendous colossal lighting facilities that will not bust.

High-jumping for the track team his first year, he injured his ankle so he couldn't continue, but has kept in contact with track since, arranging banquets and editing a track paper, *The Wastebasket*. He is a member of Spiked Shoe and of Aleph Samach.

Lew is a man of varied tastes. One binge in New York illustrates this admirably. He heard a Philharmonic concert in the afternoon, then to a duck dinner with beer, a burlesque show in the evening, and then wound up with *Lohengrin*.

Lew once made a radio set out of an orange crate, in South Orange. The set received Newark, but couldn't quite manage New York. He accumulates albums of classical records, enjoys hiking around Ithaca (but not at this season), defends the fraternity system (he is a member of Psi Upsilon), drinks with the Delta Club, is a member of Sphinx Head, haunts the ocean during the summer, and is an inveterate pulverizer of paper napkins.

Starting work on the 1936 electrical show, Lew expects that, with the help of funds from the Engineers' Ball, it will steal the Cornell Day show as usual.

Lew has done work testing relays and circuit breakers for General Electric, and hopes to work in their testing lab. after graduation.

Lew has had great success in managing E. E. functions, and his poise and quiet dignity typify the engineer headed for success.

CORNELL SOCIETY of ENGINEERS

EDWARD C. M. STAHL '13, PRESIDENT

J. D. TULLER '09, VICE PRESIDENT — S. C. HOLLISTER, VICE PRESIDENT

EDWARD B. KIRBY '25, RECORDING SECRETARY — JOHN P. SYME '26, SECRETARY AND TREASURER

"The objects of this Society are to promote the Welfare of the College of Engineering at Cornell University, its graduates and former students and to establish a closer relationship between the college and the alumni."

President's Column

February 1, 1936

Fellow Engineers:

Membership in our Society is evidence of your appreciation of the fellowship of men who are the present and future embodyment of the ideals and inspiration of the engineering profession as exemplified by the illustrious educators of our own College of Engineering. With the increasing demand that the engineer be more socially minded it is necessary today for our graduates to increase their contacts and take an active part in the problems that the new concept of the engineer requires. The article by C. F. Hirshfeld '05 in the January issue "The Engineer Becomes Self-conscious" gives a most forceful picture of the situation and reviews the joint efforts being made by the major national engineering groups, to bring about not only the proper public recognition of the engineering profession but the development of social and economic mindedness among the engineers themselves. It is most gratifying that this Engineering Council for Professional Development selected as its first Chairman and again re-elected a Cornell engineering alumnus, in the person of C. F. Hirshfeld. With both our faculty and alumni engaged in the active leadership of the profession toward the attainment of the new concept of the engineer, your Society may well take an energetic part. It is significant that ever since our Society was founded in 1907 the roster of active membership throughout the country was made up principally of alumni who had or since have attained a measure of prominence in their locality and in many cases national prominence. In other words, membership was one expression of the inherent social mindedness of the individual. Until recently no special effort has been directed toward developing one of the essential qualifications for the individual's as well as the profession's success in the public eye. As a result only a small proportion of engineers, with an inherent capacity for perceiving their obligations to the social structure, took any interest in the now urgent human aspects of their profession. However, this is no reflection either on the schools or the engineers as until recently the demands for technicians exceeded the supply. It is furthermore to the credit of the engineer that he was absorbed in the struggle to overcome nature and harness her to the burdens of humanity. Now that he has gone far in this direction and found that non-technical people are at a loss to control his developments he must attend to this control and will.

The Cornell Society of Engineers is not a technical society. It is one of human relationships centered around our common heritage. We are, therefore, in a position to offer encouragement and many examples of accomplishment in the matter of putting Cornell engineers within the newly accepted definition of broad gage engineers.

Trial and error is the major tool of advancement. Mass emotion still rules in human affairs. The analysis and control of emotion will take its place for the engineer alongside of the control of physical forces and perhaps the development along these lines will be proportional to the technical advances. The scientist has given us the basic facts for technical engineering. The psychologist and the economist have given us some of the basic material from which to develop human engineering. Now that we know a serious problem must be solved, the engineering profession will most assuredly devote its enthusiasm to it.

In carrying out the aims and objects of this Society we cannot neglect the pursuit of human engineering. We hope that as the local sections of our members develop this matter will take a prominent part in stimulating greater individual success.

Sincerely,

EDWARD C. M. STAHL, *President*

"Newfangled invention" makes good

"Can you really talk through a wire?" people still asked when this early telephone switchboard went into service in 1881. ¶ Apparatus was crude—service limited—but the *idea* was right. It took hold in spite of ridicule. Today there are more than 13,000,000 telephones in the Bell System—telephone conversations average 60,000,000 daily—the service is faster and clearer than ever. ¶ Telephone growth and improvement will go on. For Bell System men and women work constantly toward one goal: enabling you to talk to anyone, anywhere, anytime.

Why not call Mother and Dad tonight? For lowest rates, call by number after 7 P.M.

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Anthropology

THE DAWN MAN

(Family: Iview withalarm)

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The photo clearly shows that this modest-acting gent is about to proclaim—"I Point With Pride, and View With Alarm!" etc.; proving to all students of anthropology in this vale of tears, that man has changed but little in a hundred thousand years.

Nothing like a good photograph to clear up any doubts which might exist about the appearance of our noble ancestors.

"Use More and More Good Pictures."

Ithaca Engraving Co.

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ENGINEERING EDUCATION

(*Continued from page one hundred six*)

admirable field for advertising, superior even to a good football team.

There is too large a proportion of career pedagogues in our Engineering faculties. For real inspiration a student should be in contact with two types of mind in the faculty. Let us say that 50% of the faculty should be men with a high degree of technical attainment plus the ability to elucidate their subject. These men are what might be called the career pedagogues. Any one who has studied under Professor Church will appreciate the importance of this type. Another large porportion of the faculty should be men of achievement. The writer does not hesitate in saying that men like Fuertes, Gardner, Williams and Professor Ogden were capable of inspiring a high degree of enthusiasm and inspiration which the purely career pedagogue could rarely inspire.

Under such a system aspiring career pedagogues will naturally be forced to move out into active practice or to other colleges. This will have in the long run a broadening and beneficial effect on their own careers.

It is urged that financial considerations do not place a bar on obtaining men of achievement. There are plenty of successful men possessing either an independent income or a partially independent income who could be obtained to take chairs in the different branches of engineering, and who would bring with them the energy and ability which they have used in lifting themselves above the common herd. In this respect one hears rumors of dry rot in the faculty structure. Of course we all know that arch enemy of efficiency in an organization, viz nepotism, is bound to eat into a permanent organization such as a college faculty.

In addition to this it is said that if a man rises to be an assistant professor he is sure of a lifetime job.

No businesses who have to exist in the face of severe competition could carry on if this attitude was taken in regard to its officers. Certainly when we consider the rise and reputation of the competing engineering schools we cannot afford to overlook these causes of decay.

The writer realizes that there are some excellent men in our Engineering faculty at present, and that some very progressive work is being done, but believes this is in spite of certain evils existing in the system of selection and promotion of teachers. At any rate to be helpful one must be frank and let the chips fall where they may.

We want our graduates to rise above mediocrity. If so, we must give them a faculty which rises above mediocrity, also more than mediocre equipment. We must give them a chance to expand their natural abilities other than technical while in college. We must give them every opportunity to assimilate permanently certain basic subjects. To do this we must provide for an inspired faculty, improved equipment, emphasized assimilation, and provide for the development of the man himself through extra curricula activities and through a broader cultural scope.

INTRODUCING ACCOUNTING

(*Continued from page one hundred thirteen*)

true in a world where economic changes were so slow as to be almost imperceptible, as, say, in the Middle Ages in Europe. However, we are well aware that we are not living in such a period in the world's history. Economic changes are rapid and devastating. This, I think, shows the falsity of the "instantaneous photograph" assumption. What then is the truth? As I see it, the balance sheet is a continuous narrative, much as the income account (sheet) is, except that the narrative is told from a different standpoint and covers the entire life of a corporation from its inception to the date of the accounts. The income account (sheet) is a narrative showing the nature and extent of the transactions involved in the production of income, such as sales, purchases, manufacturing costs and the miscellaneous items of income and expense. The balance sheet is a narrative of investment. It shows the investment in fixed assets, the estimated wear and tear through depreciation and other deductions, and it shows the amount invested in assets which are to be consumed in the operation of the business. It also indicates how much capital was contributed, who contributed it and the rights to and participation in capital of stockholders, bondholders and various other creditors . . . "

THE DIAGRAMMATIC LEDGER.—Much of the difficulty in presenting the mechanics of accounting comes about because of, (1) the inability of the average student to grasp and visualize the over-all picture of a set of accounts; and (2) the monotonous detail involved in skipping from page to page of an ordinary ledger book in an attempt to follow through the effects of even a single transaction.

To a large measure this confusion may be avoided by the use of a rather ingenious plan of showing a representative number of ledger accounts, suitably classified upon one page. Such a chart is shown in Figure 5. It forms the backbone of teaching the fundamental technique of ledger entries, at least so far as this text is concerned. By using it, you may readily visualize the two-fold effect of the double entry method which is the basis of all modern accounting systems. For example, if a transaction involves the sale of an article for cash, account number 1, the Cash Account, and account number 401, the Sales Account will be affected. Instead of turning to page 1 of the ledger book to make the Cash entry and page 401 to make the Sales entry, both entries may be made (in abbreviated form, of course) *on one page*. This gives you the paramount advantage of visualizing at one glance the complete effects of the transaction.

You should realize, of course, that the diagrammatic ledger employed in this fashion is merely for *teaching technique*, and that it is used primarily to enable you to acquire rapidly and clearly the fundamental principles involved. Once you have these principles clearly in mind, the transition to actual accounting sheets and ledgers is a relatively simple process.

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SCHOOL NOTES

FACULTY PAPER PRESENTED

At the winter convention of the A.I.E.E.. Professor M. G. Malti, a member of this Board, presented a paper entitled "A Generalized Infinite Integral Theorem."

The paper which was published in the November issue of Electrical Engineering, pages 1222-1227 aroused considerable interest and discussion. Following his presentation of this paper Professor Malti received correspondence concerning it from engineers associated with utilities, communications, and manufacturing.

The paper is an extension of Oliver Heaviside's work and deals with transient phenomena in electric circuits. Since it is highly mathematical and extremely difficult to abstract, we suggest that the interested reader refer to the original paper.

The CORNELL ENGINEER sincerely hopes that more papers will be presented by the Faculty of Engineering to the various professional societies.

—o—

LABORATORY

The Civil Engineers are patiently awaiting the arrival of their new testing machine which has been delayed by the makers and will probably be ready sometime about the first of April. The foundation for this apparatus, located in the testing laboratory in the north portion of Lincoln Hall, was completed in December.

To make sufficient room for this huge machine, which has a capacity for testing specimens up to 16½ inches diameter by 17 feet long and exerting a force of 300,000 pounds in compression, bending or tension, it has been necessary to remove part of the main floor of the Civil Engineering Building.

—o—

NEW ELECTRONICS COURSE

Due to the development of the subject of Electronics, the Electrical Engineering School has changed its curriculum on this subject, creating a new course under the tutelage of Professors W. C. Ballard and B. K. Northrup. As outlined, this new course will treat the subject not from the viewpoint of use in connection with communication, but will contain more basic electron theory so that application can be made in fields desired.

In connection with the course, a new laboratory is being constructed. It will contain, in the line of equipment, a modern steel cage, 6 phase, grid control, with complete vacuum apparatus, mercury arc rectifier, which may also be used as an inverter. Further apparatus includes thermionic, gas conduction, and other types of modern tubes.

This course is compulsory for the junior electrical engineers, replacing one term of junior Electrical Laboratory.

STRESS and STRAIN

Our favorite exam story is about the mech. lab. final—the one given for AE's and EE's. Prof. Andrea's question gave data on a water turbine, and the students were asked to compute its efficiency. Our hero struggled manfully, slipping his newly-oiled slip stick and applying the Sibley constant wherever it seemed indicated—but the answer remained unchanged. He got the efficiency to be 750%. After the exam, recuperating in the Straight, he saw Prof. Andrae lunching with Mr. Rubert, and went over to find where he'd got mixed up. Prof. Andrae obligingly pulled from his pocket a slip of paper with the problem's solution, which showed the turbine's efficiency to be 75%. After scrutinizing the paper briefly, our hero pointed out to the professor a wandering decimal point. "I guess you're right, at that," Prof. Andrae told him; and turning to Mr. Rubert, he said sorrowfully, "Well, it looks as though I've busted the final." We reckon so, Professor—but if you could just put that general idea for water turbines on a practical basis—

* * *

For the benefit of the Freshmen we are printing the following story, which made the rounds last year.

It seems that a fair size bridge, which had been under construction for quite a while, was nearing completion. One evening after the men had quit for the night, the entire structure collapsed. On the following morning, the "big shots" went down to the scene of the accident to determine what could be done. When they arrived they saw a lone figure sitting atop one of the girders which jutted out from the water. He was furiously pushing a slide rule back and forth, and seemed to be muttering, "Damn that decimal point."

* * *

You've heard about the shovel presented by his students to Prof. (E. theory) Strong, and how the gift was ignored until the final, when it was used to pass out the papers. Well, this same shovel made another public appearance. At the E.E. junior-senior smoker, the seniors were the hosts, the juniors the guests, and the faculty were decorations. Also each faculty member was called upon to entertain the boys. Came Prof. Strong's turn, and he brought out his prized shovel. He had strung it with a length of catgut, and from this dainty instrument he drew forth the strains of our Alma Mater.

* * *

Also, while telling these, what you would do if you were one of the two frosh who stood outside his Hygiene lecture window, matching to see who would go in to answer for both. The trouble comes in when the winner goes home, and the loser turns around to go in, and sees the Prof standing in the window watching the whole arrangement.

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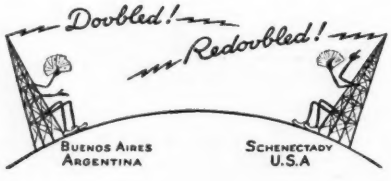
G-E *Campus News*

CRASH!

IT'S a thunderstorm sweeping over Pittsfield, Massachusetts. But G-E engineers, instead of hiding under the bed, go up on the roof to be nearer the lightning. On one of the buildings of the Pittsfield Works they have built and equipped a lightning observatory. By means of an ingenious periscope and a high-speed, motor-driven camera, any lightning flash occurring within many miles—north, south, east, or west—can be automatically photographed. Its characteristics, as recorded on the film, can then be compared with those of the artificial flashes produced by the 10,000,000-volt lightning generator in the laboratory.

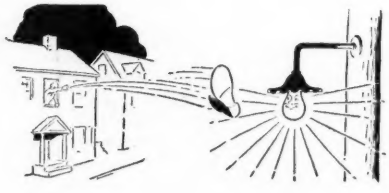
An observatory has to have a hole in the roof. This causes astronomers no embarrassment, because they can work only in clear weather. But with lightning observers it is different—when there is lightning there is also rain. So, to keep the rain from falling on the 12 lenses of the new camera—and from running down the engineers' necks—compressed air is blown upward through the aperture. When next the thunder rolls over the Berkshires, and timid citizens are cowering under the bedclothes, these General Electric engineers will be up on the roof taking elaborate notes on Jove's own brand of lightning.



GAME BID

DOUBLED! Redoubled! North led, but the dummy was 6000 miles away. Psychic bids flew thick and fast when a North American contract-bridge team, including Mr. and Mrs. Ely Culbertson, played a "bridgecast" tournament with a high-ranking team from Argentina. The North Americans were seated on the stage of Rice Hall in the General Electric Company, at Schenectady, N. Y., while the Argentine team played at the Casabal Club in Buenos Aires. The plays were carried by the short-wave stations W2XAF and LSX, of North and South America, respectively.

W2XAF, in Schenectady, used a feed-back circuit so that short-wave listeners all over the world, tuned to the one station, could follow the playing with as great ease as the 500 kibitzers who jammed Rice Hall. This was the first international bridge broadcast in which the principals were all recognized experts. The North American team, captained by Culbertson, won by a margin of 1030 points.



BEDROOM PRIVACY

MANY a man has shinned up a lamppost to daub paint on a street lamp that shone in his bedroom window. Many another light sleeper, of lesser climbing prowess, has tried throwing shoes and hair brushes at the offending light. Now there is hope that this war will soon be over.

Adequate street lighting is, of course, a necessity. G-E illumination engineers have perfected a new fixture that directs the light where it is needed—on the street—and keeps it from trespassing on the pillow. A concealed light source and a reflector designed along new optical lines have removed street lamps from the list of public enemies of sleep. Motorists, too, will welcome these new luminaires. Because the reflector extends below the incandescent source, the driver's eyes are protected from direct glare—he can see the road better.

96-227DH

GENERAL ELECTRIC